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Telecommunications Course Content: Input from Information Technology Professionals

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ABSTRACT

Preparing students to be competent in the Information Technology (IT) world is a goal of technology-based departments in colleges and universities. Telecommunications is one part of the IT area in which students need to be prepared. Many colleges and universities teach telecommunications courses at different levels or incorporate telecommunications topics in more than one course. This, along with the challenge of keeping up with an ever-changing information technology environment, provides a challenge to academicians. Seeking input from IT professionals is one way to help keep curricula current. This research is an extension of a 1997 Delphi study dealing with telecommunications course content for a beginning telecommunications course at the college or university level. The 1997 participants were members of the Organizational Systems Research Association (OSRA) and had either taught telecommunications topics and/or researched in the area. The final course content topics and subtopics from the 1997 study served as Round one data for the participants of this 2003 Delphi study. The participants were members of the Association of Information Technology Professionals (AITP). This study identifies the common consent (two-thirds of the participants rating the topics/subtopics with a 5 – Definitely Do Include the Topic) and the consensus (all participants rating the topics/subtopics with a 5) course content lists for a telecommunications course taught at the college/university level.

Keywords: Telecommunications, AITP, Course Content, Course Development

1. BACKGROUND

As the enormous amount of telecommunications products and applications continue to grow and surround us in our daily lives, it is important to keep the telecommunications curriculum current. The information technology (IT) environment consists of a wide variety of technological challenges to prepare information technology graduates. As the information technology environment rapidly changes, this poses a challenge not only for Management Information Systems (MIS) managers, but also for academicians (Maier, Clark, Remington, 1998). In an effort to prepare IT students for the work world, obtaining input from professionals in the field is essential.

Many colleges and universities teach telecommunications courses at different levels or incorporate telecommunications topics in more than one course. Yurcik (2001) notes that telecommunications is evolving as a separate and distinct discipline of study which is actually separate from Information Systems (IS). One challenge for educators is staying current in an ever-changing technology environment and in turn providing an up to date curriculum. It is obvious that the need for Information Systems (IS) workers is growing and in demand, but the identification of the specific skills required for the variety of IS positions is not as clear (Noll & Wilkins, 2002). Management Information Systems (MIS) managers are challenged by trying to find competent workers for their positions. The proliferation of the Internet, security, data growth, and data management also pose challenges for MIS managers.

This research is an extension of a telecommunications course content Delphi study completed in 1997. The 1997 participants were members of the Organizational Systems Research Association (OSRA) and had either taught or researched in the area of telecommunications. A modified Delphi technique was utilized as the participants of this study were not provided simply with a "blank page" for course content ideas, but were provided with the common consent course curriculum topics and subtopics defined by the 1997 study. Common consent is identified in this study, and the previous study, as two-thirds of the participants rating the topics/subtopics with a 5 – Definitely Do Include the Topic. Consensus is identified in this study, and the previous study, as all participants rating the topics/subtopics with a five.

Modified Delphi studies have been completed by other researchers. Wicklein (1993) identified issues and problems in technology education by asking participants to identify critical issues and problems for technology education using four guiding questions that were created for the participants. Therefore, they did not begin with a "blank page" approach and they were also provided with definition of terms. Kelbaugh (2003) utilized a modified Delphi study to identify indicators of success in a teamwork situation. Round one consisted of statements based on research expertise and a review of literature. These participants were also not provided with a "blank page" to being the Delphi study.

The 1997 initial study consisted of 19 participants in Round One; however, 15 participants completed the study through Round Four and the results were published in a refereed journal. The number of participants in a Delphi study varies. Delbecq, Van de Ven, & Gustafson (1975) indicated that the number of respondents or panel size is variable and concluded that if a study has a homogenous group of people; ten to fifteen participants might be enough.

The Delphi method was designed originally to determine trends with a special emphasis on science and technology and their probable effects on society (Everett, 1993); however, the Delphi method is increasing being applied in other fields and for other purposes then forecasting. This methods of inquiry is a viable option for obtaining reliable consensus from experts without actually bringing the experienced individuals together face-to-face (F2F). The methodology, research design, findings, and conclusions are discussed throughout this manuscript. This research attempted to achieve consensus among IT professionals regarding the specific content of a beginning telecommunications course at the college or university level.

2. RELATED LITERATURE

Approximately ten years ago, Trauth and Farwell (1993) identified a gap between industry expectations and academic preparation. Curriculum and course updates are necessary to provide students with the essential skills needed upon graduation. Therefore, educational institutions must be willing to review curriculum and investigate how to update existing curriculum to produce the technically competent students who also have the skills necessary to succeed in the business world. "The number of workers in the computer and software industries has almost tripled in the past decade" (Freeman and Aspray, 1999, p. 35). Consequently, academia faces the difficult task of providing an up-to-date curriculum in an environment that is constantly changing. Involving industry is a viable way to gather data to keep the curricula current.

This emphasizes the need for educational institutions to obtain current industry input and help bridge the gap to produce qualified graduates who will become qualified applicants for the available positions in the information technology world. Telecommunications is a large part of the information systems environment. Those responsible for teaching key courses in the area of information technology must ensure that the curriculum and courses result in the achievement of the critical skills necessary to advance in the job market or in the advancement of education. Research by Gonzenbach (1998) resulted in the recommendation that most emphasis should be placed on teaching the following: telecommunications, operating systems, systems analysis and design, networks and business communications. The continued development in e-commerce, wireless networks, and further advances in technology will only enhance the need to update skills in telecommunications.

Yurcik (2001) notes that the Accreditation Board for Engineering and Technology, Inc. (ABET) has proposed criteria for an undergraduate degree in telecommunications engineering: 1) apply technical topics including analog/digital electronics, voice and data communications, telecommunications systems, computer programming, associated software, etc.; 2) apply physics; 3) analyze, design, and implement telecommunications systems; 4) analyze and implement switching technologies, wide area networking technologies, and policy; 5) manage, design, and plan WANs; 6) apply statistical/probability and applied differential equations in support of telecommunications systems and WANs.

Accrediting bodies are just one type of organization looking in the area of telecommunications. Corporations are also interested in dealing with changes and forecasting the future. One way that industry has done this is to complete Delphi studies in the telecommunications area. The Business Planning Group of Bell Canada surveyed the following changes in telecommunications: 1) merging computer and communications technologies; 2) regulatory changes introducing new competitive elements; 3) emerging visual telecommunications markets; 4) perceived and projected social changes; and 5) increasing costs of investment options as early as 1960 as it was studying rends in the visual and computer communications fields. It was discovered that there was a lack of qualitative data on potential futures for these fields and upon further investigation of methods of inquiry, the Delphi techniques was implemented to fill the information gap that was perceived at that time (Day, 2002).

Security has been an important element in telecommunications, and will become more important in the future. Network security and encryption of passwords are gaining more attention as businesses and educational institutions install wireless networks. Due to the access to data and the flaws in network topologies, improved security is necessary. Improved security standards are being developed by the Institute of Electrical and Electronics Engineers (IEEE). Network administrators are learning how to update, maintain, and protect their data,

users, and investment in telecommunications environments without wires.

As the implementation of wireless networks began, the Bluetooth (BT) Consortium was founded in 1998. The main focus of this consortium is to eliminate the hard wire cabling and connect devices via a universal radio link. This type of open system platform will provide for voice and data through a wireless connection. These "virtual" networks are wirelessly connected devices that create a Wireless Personal Area Network (WPAN) that will allow desktops, mobile phones, pagers, handheld devices, and the like to be connected (Warring, Galli, Kerpez, & Ungar, 2000). Along with BT and WPAN, IEEE developed 802.11x wireless networking standards. IEEE wireless networking standards 802.11a and 802.11b were thought to enhance the ability to exchange data in a wireless environment. The 802.11g wireless network uses the same radio frequency as 802.11b.

These specifications are related to a connection between two wireless clients or a wireless client and a base station. It involves an over-the-air interface and the specifications are broken down into 802.11a, 802.11b, and 802.11g. These specifications and the desire for voice over IP (VoIP) are advancing the telecommunications industry. VoIP is basically the ability to send voice using the Internet protocol. The voice is sent in digital form in packets and the major advantage is that it avoids the charges from ordinary telephone services (TechTarget, 2003). The impact these developments are having on the telecommunications industry is enormous. Hoplin (1995) provides an interesting thought as he summarizes changes in technology and IS success as "the rapid proliferation of emerging information technologies drives home the point that IS cannot run in place without losing ground" (p. 1).

3. RESEARCH DESIGN

The Delphi method is a set of procedures for eliciting and refining the opinions of a group (Dalkey, 1967 & Brown, 1968). This method was used in the previous (1997) study and current (2003) study. The 2003 Delphi study allowed a group of IT professionals to come to consensus on telecommunications course content topics and subtopics as well as evaluate the importance of content items. Linstone and Turoff (1975) summarize the Delphi method best by stating, "Delphi may be characterized as a method for structuring a group communication process, so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (p. 3). The Delphi method has been used effectively by government agencies, policy research organizations, and a variety of institutions and has become widely accepted (Day, 2002).

Two modifications of the standard Delphi technique were employed. First, the researcher provided the participating panel with an initial list of telecommunications topics defined by the common consent course content from the 1997 study. In Round One, the participants reacted to the course content list by providing suggestions for retention or deletion and by the addition of topics or subtopics. Topics such as Network Architectures and Securing a Network are broad categories under which more specific subtopics are identified. The same format was used for Round Two. Second, in the final two rounds (third and fourth) the participants evaluated the remaining topics using the following Likert scale:

1. Definitely Do Not Include the Topic
2. Possibly Do Not Include the Topic
3. No Opinion
4. Possibly Include the Topic
5. Definitely Do Include the Topic

Consensus occurred if all participants rated the item with a 5 – Definitely Do Include the Topic. Common consent was declared, as in the 1997 study, for topics or subtopics for which two-thirds of the panel rated the item with a 5 – Definitely Do Include the Topic. At the completion of the 1997 study, 10 topics and 30 subtopics were identified through common consent. This list was sent to the participants of the 2003 study as Round One.

4. PANEL SELECTION

The current AITP membership list was used as the basis for selecting participants for this study. Through a grant, the researcher purchased a random sample of participants from AITP. All of the AITP members included in this provided random sample were mailed a letter which explained the study and asked for their response. The members could return a facsimile response sheet agreeing to participate, acknowledging that they cannot participate, or offering a suggestion of another AITP member who could participate. The members could also respond through email. Of the 101 initial letters sent, 24 were returned undeliverable and 15 agreed to participate. Fifteen completed Rounds One and Two; however, 11 responded to Round Three and 9 responded to Round Four.

Taylor-Powell (2002) states that the number of participants in a Delphi study depends not only on the purpose of the study, but the diversity of the targeted population. Ten to fifteen participants may be an adequate number for a Delphi study that is focused and where the participants do not vary a great deal. Ludwig (1997) states that most Delphi studies have 15-20 participants and the study typically runs over a period of weeks, but the number of participants is generally determined by the number required to develop a representative pooling of judgments. The panel of experts in this study completed this study during the months of February through July 2003 to finalize this research and effectively worked to develop the telecommunications course content list.

5. PROCEDURES

After the AITP members agreed to participate and understood the goal of this research, the final common consent course content list from the 1997 study served as

the initial course content list for the 2003 study. This course content list consisted of 10 main topics and 30 subtopics. Table 1 provides the common consent telecommunications course content which served as the initial list for Round One of this study.

During Round One, each participant was instructed to add, delete, and/or edit any topics or subtopics they believed were pertinent and/or not pertinent to a college/university telecommunications course. All rounds were sent via email; however, participants could respond through email or facsimile. Round One resulted in the course content list being expanded from 10 to 15 main topics and from 30 to 83 subtopics. Round Two was also sent via email and the participants again had the opportunity to add, delete, and/or edit topics and subtopics. Round Two resulted in 11 main topics and 58

Table 1
1997 Final Course Content for a Telecommunications Course
2003 Initial Course Content for Round 1

1-10 Enumerated Items = Topics	Bulleted Items = Subtopics
1. COMMUNICATIONS MEDIA	
	• Laser
	• Wire media (twisted pair, coaxial cable, fiber optics)
	• Wireless media (radio frequency, infrared)
2. COMMUNICATIONS HARDWARE	
	• Network hardware components (servers, repeaters, hubs, bridges, routers)
	• Modem definition and application
	• Modem transmission speeds and formats (duplexing and serial/parallel)
	• Protocol
	• Multiplexing
3. CONCEPTUAL FOUNDATIONS	
	• Role of telecommunications in business
	• Introduction of network types (LANs, WANs, MANs)
	• Basic communications model (sender, encoding, transmission, decoding, receiver)
4. DATA SIGNALS	
	• Analog vs digital
	• Transmission methods (asynchronous/synchronous)
	• Transmission modes (simplex, half-duplex, duplex)
	• Modulation
5. TELECOMMUNICATION SYSTEMS	
	• Electronic mail systems
6. EMERGING TECHNOLOGIES (Local & Global)	
	• Wireless networks
	• Intranets
7. SOCIAL AND ETHICAL ISSUES	
	• Privacy and information
	• Security, crime, etc.
	• Legal issues
8. LOCAL AREA NETWORKS (LAN)	
	• Basic definition and application
	• LAN configuration (Internet working LANs: bridges, routers, gateways, etc.)
	• Network operating systems (Novell, NT Server, Banyan Vines, etc.)
9. NETWORK TOPOLOGIES	
	• Ring
	• Star
	• Bus
10. WIDE AREA NETWORKS (WAN)	
	• Integrated services digital network (ISDN)
	• Transmission speeds and bandwidth
	• Integration of networks

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Table 2

2003 Final Course Content for a Telecommunications Course: Determined by AITP Members

1-11 Enumerated Items = Topics Bulleted Items = Subtopics

1. **INTRODUCTION TO BASIC NETWORK COMPONENTS**[C]
   - Types, terms, purpose
   - Role of telecommunications in business
   - Telecommunication applications in business
   - Basic communications model (sender, encoding, transmission, decoding, receiver)
   - Network hardware components (servers, repeaters, hubs, bridges, routers)
   - Basic standards
2. **NETWORK HARDWARE AND MEDIA**
   - Wire media (twisted pair, coaxial cable, fiber optics)
   - Wireless media (radio frequency, infrared, digital satellite)
   - Network hardware components (servers, repeaters, hubs, bridges, routers)
3. **COMMUNICATING OVER THE NETWORK**
   - HTTP
   - Protocols
4. **NETWORK ARCHITECTURES**[C]
   - Network types (LANs, WANs, MANs)
   - Basic definition and application
   - LAN configuration (Internet working LANs: bridges, routers, gateways, etc.)
   - Network operating systems (Novell, NT Server, Banyan Vines, etc.)
   - Protocols (TCP/IP, NETBEUI, IPX/SPX)
   - Client server and distributed computing environments
5. **MODELS AND PROTOCOLS**
   - OSI Model
   - TCP/IP
6. **SECURING A NETWORK**[C]
   - Identifying threats to networking security[C]
   - PC and server security[C]
   - Backing up the network
   - Firewalls[C]
   - Social engineering
   - Other human security issues
   - Physical prevention system
   - Secure communication systems
7. **NETWORK MANAGEMENT AND PERFORMANCE**
   - Network design
   - Network metrics
   - Network monitoring control
8. **SOCIAL AND ETHICAL ISSUES**
   - Privacy and information
   - Best practices
9. **EMERGING TECHNOLOGIES (Local & Global)**[C]
   - Disadvantages of going completely wireless
   - Intranets (VPN)
   - Extranets

in order to allow the participants to evaluate the topics and subtopics using a Likert scale of 1-5. A score of one represented 'Definitely Do Not Include the Topic' and a score or five represented 'Definitely Do Include the Topic.'

The results of Round Three provided data to calculate a group mean from the evaluation scores of 1 to 5. Round Four was then emailed to the participants in which participants had the opportunity to review not only their rating from Round Three, but also the group mean from Round Three. Participants could then change their rating if desired. The participants were reminded that the goal of this study was to reach consensus on telecommunications course content topics and subtopics. Weaver (1971) discussed how the Delphi method follows the principle that several heads are better than one and that the experts involved make inferences based upon rational judgment rather than merely guessing. Consensus was declared if all participants rated the item with a 5 – Definitely Do Include the Topic. Common consent was declared if the item was rated 5 by two-thirds of the participants. If a participant did not respond, consensus could not be determined; however, common consent could be determined. The consensus list of subtopics is included in the common consent course content list.

Round Four resulted in common consent on 9 topics and 35 subtopics. Of these, four main topics and three subtopics reached consensus. Table 2 shows the common consent course content list which resulted from Round Four of the 2003 study. Consensus items are notes with a superscript *C* (i.e., Network Architecture).

6. FINDINGS

The following describes the findings of this study which is a result of input from IT professionals. The findings resulted in a common consent course content list for a beginning telecommunications course at the college/university level. It is noted that limitations to this study include a population consisting only of AITP members and the number of participants in this study may also be a limiting factor. However, the participants are currently involved as IT professionals and they can provide current information about business telecommunications course content. Also, Rowe and Wright (1999) noted how the number of Delphi participants varies from study to study. They investigated 27 Delphi studies and found that the rounds vary between 2 and 7 and the number of participants ranged from 3 to 98.

The modifications in topics from Round One through Round Four were extensive as every topic was changed in some way. The AITP members developed a telecommunications course content list that began with necessary telecommunications basics with a topic entitled Introduction to Basic Network Components. The Round One topic of Conceptual Foundations was greatly expanded. The generic wording of six subtopics included under this topic should allow them to continue in future studies. The Introduction of Network Types (LANs, WANs, MANs) subtopic in the original list was moved to Network Architectures and expanded upon with other subtopics.

Communication hardware and communication media expand our telecommunications capabilities. These two communication topics were combined into Network Hardware and Media and included three subtopics describing a variety of wire and wireless media. It is essential for the person selecting the media to understand why the chosen media for their particular situation is the best choice. Also, Bluetooth was an added subtopic in this area. Although common consent was not received, it may be an area worth investigating.

The emphasis on the importance for an understanding of protocols and standards is evident. TCP/IP or protocols are included as a subtopic for three main topics: 1) Communicating Over the Network; 2) Network Architectures; and 3) Models and Protocols. The original Telecommunications Systems topic was deleted and a new topic Communicating Over the Network, was created originally with nine subtopics. Two of these subtopics (HTTP and Protocols) reached common consent. Although the subtopic Electronic Mail Systems was deleted, perhaps seen as common knowledge, the subtopics expanded to include protocols and HTTP. Voice Over IP technology as well as end-user devices, including personal and cooperative applications, were included in the original nine subtopics. Although not reaching consensus, it may be important for students to understand how to communicate over the network (analog/digital) and how it affects the user and them personally in the work environment.

Local Area Networks (LANs) and Wide Area Networks (WANs), previously two topics, became two subtopics under the new topic Network Architecture. Obviously, students need to know the basic definition of a LAN or WAN, but should also have knowledge in the areas of configurations, operating systems, and protocols associated with such networks. The basic understanding of LAN/WAN topologies should evolve to knowledge of hybrids, LAN configuration, and networking operating systems. Other important subtopics that were included in this area were Client Server and Distributed Computing Environments.

The Models and Protocols topic included two subtopics: 1) TCP/IP and 2) OSI model. These two subtopics lay the foundation for understanding many other topics and subtopics in the course content list. Models and Protocols is one of two new topics in which all of the subtopics also reached common consent. The second topic in which all subtopics reached common consent was Securing a Network. It included eight subtopics varying from hardware components to physical and human security

Table 3
2003 Topics/Subtopics Not Reaching Common Consent

TOPIC/Subtopics	Mean
Integration of networks	4.6
Management tools and best practices	4.4
Network quality (reliability, availability, response time)	4.4
Analog vs digital	4.3
Federal and state telecommunications policy and (de)regulation	4.3
Hybrid	4.3
Setting up and configuring a peer to peer network and server-based network	4.3
Telecommunication systems (email systems, text paging, mobile computing, groupware)	4.3
TELEPHONY (as a basis for WANs)	4.3
Transmission speeds and bandwidth	4.3
Cable alternative	4.2
Cell Phone Technology	4.2
Introduction to communication protocols (TCP/IP, NETBEUI, IPX/SPX)	4.2
Multiplexing	4.2
Personal applications (voice mail, calendar, synchronization)	4.2
Voice over IP technology (benefits, drawbacks, etc.)	4.2
Wired telephony	4.2
End-user devices (PDA, tablets, cell phones, traditional devices)	4.1
Definition of networking topologies	4.0
Modulation	4.0
Bluetooth	3.9
Codec	3.9
Integrated Services Digital Network (ISDN)	3.7
Cooperative applications	3.6

issues. Security is being developed as a course itself in many universities or integrated into more than one course.

Network Management and Performance are also important in the IT world. This is also a new topic that emerged in the final telecommunications common consent list. Design, metrics, and monitoring are three key words when dealing with network management and performance. It is important that students understand how to implement a network, but then follow through with management of network performance.

Social and Ethical Issues continued as a topic and one subtopic remained important: Privacy and Information. In addition, a subtopic entitled Best Practices was included. Therefore, students not only need to know the importance of the privacy of information, but how to best keep it private and be ethical about securing it.

Virtual Private Networks (VPNs) are also emerging into more viable systems along with extranets. There will obviously continue to be emerging technologies and with this continual change. Wireless networks are emerging and students need to not only know how they work, but be able to analyze whether this type of network would be most appropriate while considering the advantages and disadvantages.

The one main topic that did not receive common consent was Telephony which included subtopics such as wired and cell phone technology. All topics and subtopics that did not result in common consent are listed in Table 3. The subtopics are listed in order first by Likert means and then alphabetically.

One main topic and 23 subtopics did not receive common consent. Many of these subtopics, however, were introduced in this study. It will be important to track the reoccurrence or deletion of these subtopics in future studies.

7. CONCLUSIONS

Based on the findings of this study, 4 main topics and 3 subtopics reached consensus and 5 main topics and 32 subtopics have emerged through common consent. Therefore, the final course content list includes 9 topics and 35 subtopics. These topics and subtopics represent the group decision of what IT professionals believe should comprise the core body of knowledge for a college or university course in telecommunications. Since consensus is established when all participants rated that item a 5, it is important for those teaching a beginning telecommunications course to investigate their own curriculum to see if these topics/subtopics are included. Common consent was reached when two-thirds of the participants rate a topic or subtopic 5-Definitely Do Included Topic. This is a good base to begin a new telecommunications course or update a current course.

Davis, Feinstein, Gorgone, Longenecker, and Valacich (2001) noted that developing curricula in the IS areas has been an ongoing task since the early 1970s. The IS 2002 curriculum was developed through a group effort between the Association for Computing Machinery (ACM), the Association of Information Technology Professionals (AITP), and the Association for Information Systems (AIS). This collaborative effort emphasized the need for a useful model curriculum which can be adapted to a variety of IS/IT types of degree programs. The same is true for individual courses in model programs. It is necessary to develop frameworks for others to follow when creating or updating course content. In a study by Daigle, Longenecker, Landry, and Pardue (2004), it was noted that 81% of the IS faculty surveyed were aware of the IS 2002 model curriculum and even though on 12% were committed users, the strength of using the model curriculum was noted for accreditation purposes.

A review of the IS 2002 Model Curriculum (Gorgone, Davis, Valacich, Topi, Feinstein, & Longenecker, 2002) reaffirms that the participants in this study provided up-to-date information. The IS 2002 Model Curriculum includes four knowledge areas that IS graduates should possess. Technology is one of those knowledge areas. Included in the technology area, several topics that are included in the IS 2002 Model Curriculum are also included in the common consent course content list in this study. Some examples include computer systems hardware, networking (LAN/WAN), system administration, and security.

The main topics and subtopics that resulted from this study can be used as a basis for the development of a new telecommunications course or updating an existing course. Some colleges and universities may offer more than one course in telecommunications or the topics may be incorporated throughout other IT courses. It is important, however, that the content be updated and reviewed as the telecommunications technologies change in society. Therefore, the common consent course content list developed in this study will assist in that endeavor.

8. FUTURE RESEARCH

As technology evolves quickly to create an ever changing environment, the updating of technology courses is also ever changing. For colleges/universities to keep course content and develop competent graduates, it is essential that they review their own curriculum and the curriculum of others. Further research will help others enhance their curriculum and in turn help produce quality graduates.

Some recommendations for future research in IT include completing a follow-up to the 2003 study in five years. There would then be a sequence of course content lists from 2003 and 2008. This would show the movement of technology and how important it is to gather input from IT professionals to keep up with the changing technologies in the classroom. It is also important to complete similar studies in other IT areas. There is a wide variety of courses taught in this area and it is necessary to stay current with topics to include in coursework. Research provides that opportunity.

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